



$$I^G(J^{PC}) = 0^+(0^{-+})$$

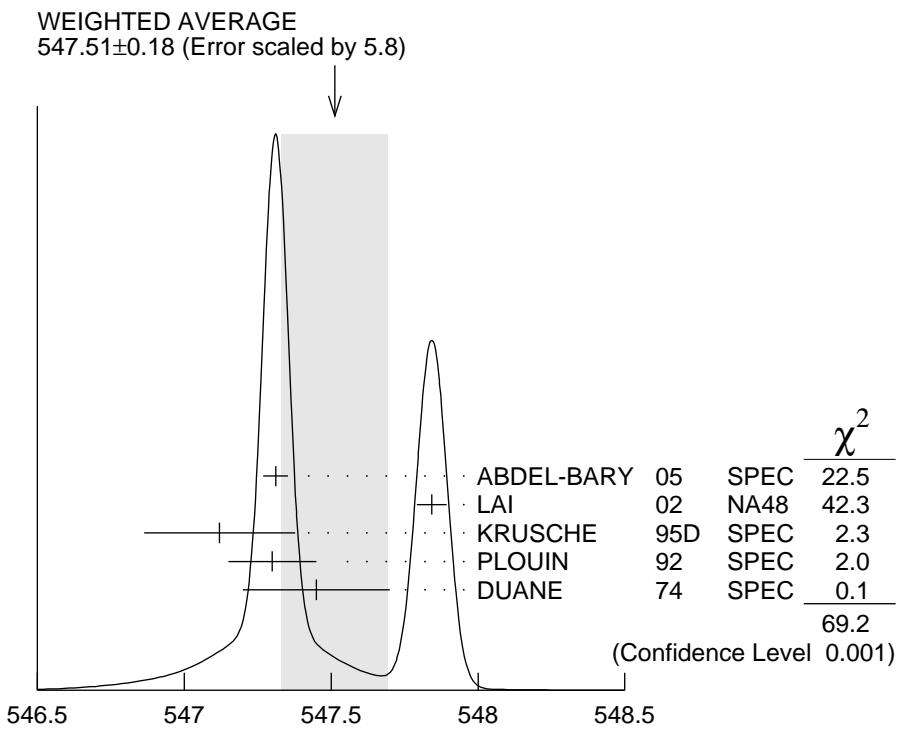
We have omitted some results that have been superseded by later experiments. The omitted results may be found in our 1988 edition Physics Letters **B204** (1988).

## $\eta$ MASS

We no longer use the bubble-chamber measurements from the 1960's, which seem to have been systematically high by about 1 MeV. (However, note that the latest measurement is midway between those old values and the newer ones.) Some early results have been omitted altogether.

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
<b>547.51 ±0.18 OUR AVERAGE</b>		Error includes scale factor of 5.8. See the ideogram below.		
547.311±0.028±0.032		<sup>1</sup> ABDEL-BARY 05	SPEC	$d p \rightarrow {}^3\text{He} X$
547.843±0.030±0.041	1134	<sup>1</sup> LAI 02	NA48	$\eta \rightarrow 3\pi^0$
547.12 ±0.06 ±0.25		KRUSCHE 95D	SPEC	$\gamma p \rightarrow \eta p$ , threshold
547.30 ±0.15		PLOUIN 92	SPEC	$d p \rightarrow \eta {}^3\text{He}$
547.45 ±0.25		DUANE 74	SPEC	$\pi^- p \rightarrow n$ neutrals
• • • We do not use the following data for averages, fits, limits, etc. • • •				
548.2 ±0.65		FOSTER 65C	HBC	
549.0 ±0.7	148	FOELSCHE 64	HBC	
548.0 ±1.0	91	ALFF-...	62	HBC
549.0 ±1.2	53	BASTIEN 62	HBC	

<sup>1</sup> ABDEL-BARY 05 and LAI 02 disagree significantly.



## $\eta$ WIDTH

This is the partial decay rate  $\Gamma(\eta \rightarrow \gamma\gamma)$  divided by the fitted branching fraction for that mode. See the note at the start of the  $\Gamma(2\gamma)$  data block, next below.

VALUE (keV)  
 **$1.30 \pm 0.07$  OUR FIT**

DOCUMENT ID

## $\eta$ DECAY MODES

Mode	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level
<b>Neutral modes</b>		
$\Gamma_1$ neutral modes	$(72.0 \pm 0.4) \%$	S=1.3
$\Gamma_2$ $2\gamma$	[a] $(39.39 \pm 0.24) \%$	S=1.2
$\Gamma_3$ $3\pi^0$	$(32.52 \pm 0.26) \%$	S=1.2
$\Gamma_4$ $\pi^0 2\gamma$	$(4.4 \pm 1.6) \times 10^{-4}$	S=2.0
$\Gamma_5$ $\pi^0 \pi^0 \gamma\gamma$	$< 1.2 \times 10^{-3}$	CL=90%
$\Gamma_6$ invisible	$< 6 \times 10^{-4}$	CL=90%

### Charged modes

$\Gamma_7$	charged modes	(28.0 $\pm$ 0.4 ) %	S=1.3
$\Gamma_8$	$\pi^+ \pi^- \pi^0$	(22.68 $\pm$ 0.35) %	S=1.3
$\Gamma_9$	$\pi^+ \pi^- \gamma$	( 4.69 $\pm$ 0.10) %	S=1.1
$\Gamma_{10}$	$e^+ e^- \gamma$	( 6.0 $\pm$ 0.8 ) $\times 10^{-3}$	S=1.4
$\Gamma_{11}$	$\mu^+ \mu^- \gamma$	( 3.1 $\pm$ 0.4 ) $\times 10^{-4}$	
$\Gamma_{12}$	$e^+ e^-$	< 7.7 $\times 10^{-5}$	CL=90%
$\Gamma_{13}$	$\mu^+ \mu^-$	( 5.8 $\pm$ 0.8 ) $\times 10^{-6}$	
$\Gamma_{14}$	$e^+ e^- e^+ e^-$	< 6.9 $\times 10^{-5}$	CL=90%
$\Gamma_{15}$	$\pi^+ \pi^- e^+ e^-$	( 4.2 $\pm$ 1.2 ) $\times 10^{-4}$	
$\Gamma_{16}$	$\pi^+ \pi^- 2\gamma$	< 2.0 $\times 10^{-3}$	
$\Gamma_{17}$	$\pi^+ \pi^- \pi^0 \gamma$	< 5 $\times 10^{-4}$	CL=90%
$\Gamma_{18}$	$\pi^0 \mu^+ \mu^- \gamma$	< 3 $\times 10^{-6}$	CL=90%

### Charge conjugation ( $C$ ), Parity ( $P$ ), Charge conjugation $\times$ Parity ( $CP$ ), or Lepton Family number ( $LF$ ) violating modes

$\Gamma_{19}$	$\pi^0 \gamma$	$C$	< 9	$\times 10^{-5}$	CL=90%
$\Gamma_{20}$	$\pi^+ \pi^-$	$P, CP$	< 1.3	$\times 10^{-5}$	CL=90%
$\Gamma_{21}$	$\pi^0 \pi^0$	$P, CP$	< 4.3	$\times 10^{-4}$	CL=90%
$\Gamma_{22}$	$\pi^0 \pi^0 \gamma$	$C$	< 5	$\times 10^{-4}$	CL=90%
$\Gamma_{23}$	$\pi^0 \pi^0 \pi^0 \gamma$	$C$	< 6	$\times 10^{-5}$	CL=90%
$\Gamma_{24}$	$3\gamma$	$C$	< 1.6	$\times 10^{-5}$	CL=90%
$\Gamma_{25}$	$4\pi^0$	$P, CP$	< 6.9	$\times 10^{-7}$	CL=90%
$\Gamma_{26}$	$\pi^0 e^+ e^-$	$C$	[b] < 4	$\times 10^{-5}$	CL=90%
$\Gamma_{27}$	$\pi^0 \mu^+ \mu^-$	$C$	[b] < 5	$\times 10^{-6}$	CL=90%
$\Gamma_{28}$	$\mu^+ e^- + \mu^- e^+$	$LF$	< 6	$\times 10^{-6}$	CL=90%

[a] Due to removing an old measurement from the average, this is 0.11 keV larger than the width we gave in our 2002 edition,  $1.18 \pm 0.11$  keV. See the  $\Gamma(2\gamma)$  data block in the Data Listings.

[b]  $C$  parity forbids this to occur as a single-photon process.

### CONSTRAINED FIT INFORMATION

An overall fit to a decay rate and 19 branching ratios uses 45 measurements and one constraint to determine 9 parameters. The overall fit has a  $\chi^2 = 21.9$  for 37 degrees of freedom.

The following *off-diagonal* array elements are the correlation coefficients  $\langle \delta x_i \delta x_j \rangle / (\delta x_i \cdot \delta x_j)$ , in percent, from the fit to the branching fractions,  $x_i \equiv \Gamma_i / \Gamma_{\text{total}}$ . The fit constrains the  $x_i$  whose labels appear in this array to sum to one.

$x_3$	43							
$x_4$	-1	-1						
$x_8$	-81	-82	-2					
$x_9$	-62	-64	-2	63				
$x_{10}$	-9	-9	0	-7	-6			
$x_{11}$	0	0	0	-1	0	0		
$x_{15}$	-1	-1	0	-2	-1	0	0	
$\Gamma$	-12	-5	0	10	7	1	0	0
	$x_2$	$x_3$	$x_4$	$x_8$	$x_9$	$x_{10}$	$x_{11}$	$x_{15}$

Mode	Rate (keV)	Scale factor
$\Gamma_2$ $2\gamma$	[a] $0.510 \pm 0.026$	
$\Gamma_3$ $3\pi^0$	$0.421 \pm 0.022$	
$\Gamma_4$ $\pi^0 2\gamma$	$(5.7 \pm 2.0) \times 10^{-4}$	1.9
$\Gamma_8$ $\pi^+ \pi^- \pi^0$	$0.294 \pm 0.016$	
$\Gamma_9$ $\pi^+ \pi^- \gamma$	$0.0608 \pm 0.0035$	
$\Gamma_{10}$ $e^+ e^- \gamma$	$0.0078 \pm 0.0011$	1.3
$\Gamma_{11}$ $\mu^+ \mu^- \gamma$	$(4.0 \pm 0.6) \times 10^{-4}$	
$\Gamma_{15}$ $\pi^+ \pi^- e^+ e^-$	$(5.5 \pm 1.5) \times 10^{-4}$	

## $\eta$ DECAY RATES

### $\Gamma(2\gamma)$

### $\Gamma_2$

See the table immediately above giving the fitted decay rates. Following the advice of NEFKENS 02, we have removed the Primakoff-effect measurement from the average. See also the "Note on the Decay Width  $\Gamma(\eta \rightarrow \gamma\gamma)$ ," in our 1994 edition, Phys. Rev. D**50**, 1 August 1994, Part I, p. 1451, for a discussion of the various measurements.

VALUE (keV)	EVTS	DOCUMENT ID	TECN	COMMENT
<b><math>0.510 \pm 0.026</math> OUR FIT</b>				
<b><math>0.510 \pm 0.026</math> OUR AVERAGE</b>				
0.51 $\pm 0.12 \pm 0.05$	36	BARU	90	$e^+ e^- \rightarrow e^+ e^- \eta$
0.490 $\pm 0.010 \pm 0.048$	2287	ROE	90	$e^+ e^- \rightarrow e^+ e^- \eta$
0.514 $\pm 0.017 \pm 0.035$	1295	WILLIAMS	88	$e^+ e^- \rightarrow e^+ e^- \eta$
0.53 $\pm 0.04 \pm 0.04$		BARTEL	85E	$e^+ e^- \rightarrow e^+ e^- \eta$
		JADE		

• • • We do not use the following data for averages, fits, limits, etc. • • •

0.64 ± 0.14	± 0.13	AIHARA	86	TPC	$e^+ e^- \rightarrow e^+ e^- \eta$
0.56 ± 0.16		WEINSTEIN	83	CBAL	$e^+ e^- \rightarrow e^+ e^- \eta$
0.324 ± 0.046		BROWMAN	74B	CNTR	Primakoff effect
1.00 ± 0.22		<sup>2</sup> BEMPORAD	67	CNTR	Primakoff effect

<sup>2</sup> BEMPORAD 67 gives  $\Gamma(2\gamma) = 1.21 \pm 0.26$  keV assuming  $\Gamma(2\gamma)/\Gamma(\text{total}) = 0.314$ .

Bemporad private communication gives  $\Gamma(2\gamma)^2/\Gamma(\text{total}) = 0.380 \pm 0.083$ . We evaluate this using  $\Gamma(2\gamma)/\Gamma(\text{total}) = 0.38 \pm 0.01$ . Not included in average because the uncertainty resulting from the separation of the coulomb and nuclear amplitudes has apparently been underestimated.

## $\eta$ BRANCHING RATIOS

### Neutral modes

#### $\Gamma(\text{neutral modes})/\Gamma_{\text{total}}$

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
<b>0.720 ± 0.004 OUR FIT</b>		Error includes scale factor of 1.3.		
<b>0.705 ± 0.008</b>	16k	BASILE	71D	CNTR MM spectrometer
• • • We do not use the following data for averages, fits, limits, etc. • • •				

0.79 ± 0.08 BUNIATOV 67 OSPK

#### $\Gamma_1/\Gamma = (\Gamma_2 + \Gamma_3 + \Gamma_4)/\Gamma$

#### $\Gamma(2\gamma)/\Gamma_{\text{total}}$

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
<b>0.3939 ± 0.0024 OUR FIT</b>		Error includes scale factor of 1.2.		
<b>0.3949 ± 0.0017 ± 0.0030</b>	65k	ABEGG	96	SPEC $p d \rightarrow {}^3\text{He} \eta$

#### $\Gamma(2\gamma)/\Gamma(\text{neutral modes})$

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
<b>0.5474 ± 0.0019 OUR FIT</b>				
<b>0.548 ± 0.023 OUR AVERAGE</b>		Error includes scale factor of 1.5.		
0.535 ± 0.018		BUTTRAM	70	OSPK
0.59 ± 0.033		BUNIATOV	67	OSPK
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.52 ± 0.09	88	ABROSIOMOV	80	HLBC
0.60 ± 0.14	113	KENDALL	74	OSPK
0.57 ± 0.09		STRUGALSKI	71	HLBC
0.579 ± 0.052		FELDMAN	67	OSPK
0.416 ± 0.044		DIGIUGNO	66	CNTR Error doubled
0.44 ± 0.07		GRUNHAUS	66	OSPK
0.39 ± 0.06		<sup>3</sup> JONES	66	CNTR

#### $\Gamma_2/\Gamma = \Gamma_2/(\Gamma_2 + \Gamma_3 + \Gamma_4)$

<sup>3</sup> This result from combining cross sections from two different experiments.

#### $\Gamma(3\pi^0)/\Gamma(\text{neutral modes})$

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
<b>0.4520 ± 0.0019 OUR FIT</b>				
<b>0.439 ± 0.024</b>		BUTTRAM	70	OSPK

#### $\Gamma_3/\Gamma_1 = \Gamma_3/(\Gamma_2 + \Gamma_3 + \Gamma_4)$

• • • We do not use the following data for averages, fits, limits, etc. • • •

0.44	$\pm 0.08$	75	ABROSIOMOV	80	HLBC
0.32	$\pm 0.09$		STRUGALSKI	71	HLBC
0.41	$\pm 0.033$		BUNIATOV	67	OSPK Not indep. of $\Gamma(2\gamma)/\Gamma(\text{neutral modes})$
0.177	$\pm 0.035$		FELDMAN	67	OSPK
0.209	$\pm 0.054$		DIGIUGNO	66	CNTR Error doubled
0.29	$\pm 0.10$		GRUNHAUS	66	OSPK

### $\Gamma(3\pi^0)/\Gamma(2\gamma)$

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
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**0.826  $\pm 0.006$  OUR FIT**

**0.826  $\pm 0.007$  OUR AVERAGE**

0.817 $\pm 0.012 \pm 0.032$	17.4k	4 AKHMETSHIN 05	CMD2	$e^+ e^- \rightarrow \phi \rightarrow \eta\gamma$
0.826 $\pm 0.024$		ACHASOV 00D	SND	$e^+ e^- \rightarrow \phi \rightarrow \eta\gamma$
0.832 $\pm 0.005 \pm 0.012$		KRUSCHE 95D	SPEC	$\gamma p \rightarrow \eta p$ , threshold
0.841 $\pm 0.034$		AMSLER 93	CBAR	$\bar{p}p \rightarrow \pi^+ \pi^- \eta$ at rest
0.822 $\pm 0.009$		ALDE 84	GAM2	

• • • We do not use the following data for averages, fits, limits, etc. • • •

0.796 $\pm 0.016 \pm 0.016$		ACHASOV 00	SND	See ACHASOV 00D
0.91 $\pm 0.14$		COX 70B	HBC	
0.75 $\pm 0.09$		DEVONS 70	OSPK	
0.88 $\pm 0.16$		BALTAY 67D	DBC	
1.1 $\pm 0.2$		CENCE 67	OSPK	
1.25 $\pm 0.39$		BACCI 63	CNTR	Inverse BR reported

<sup>4</sup> Uses result from AKHMETSHIN 01B.

### $\Gamma(\pi^0 2\gamma)/\Gamma_{\text{total}}$

Early results are summarized in the review by LANDSBERG 85.

### $\Gamma_4/\Gamma$

VALUE (units $10^{-4}$ )	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
<b>4.4 <math>\pm 1.6</math> OUR FIT</b>			Error includes scale factor of 2.0.		
<b>3.5 <math>\pm 0.7 \pm 0.6</math></b>		1.6k	5, <sup>6</sup> PRAKHOV 05	CRYB	$p(720 \text{ MeV}/c) \pi^- \rightarrow n\eta$

• • • We do not use the following data for averages, fits, limits, etc. • • •

<8.4	90	7	ACHASOV 01D	SND	$e^+ e^- \rightarrow \phi \rightarrow \eta\gamma$
<30	90	0	DAVYDOV 81	GAM2	$\pi^- p \rightarrow \eta n$

<sup>5</sup> Normalized using  $\Gamma(\eta \rightarrow 2\gamma)/\Gamma = 0.3943 \pm 0.0026$ .

<sup>6</sup> This measurement and the independent analysis of the same data by KNECHT 04 both imply a lower value of  $\Gamma(\pi^0 2\gamma)$  than the one obtained by ALDE 84 from  $\Gamma(\pi^0 2\gamma)/\Gamma(2\gamma)$ .

### $\Gamma(\pi^0 2\gamma)/\Gamma(2\gamma)$

### $\Gamma_4/\Gamma_2$

VALUE (units $10^{-3}$ )	EVTS	DOCUMENT ID	TECN	CHG	COMMENT
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**1.1  $\pm 0.4$  OUR FIT** Error includes scale factor of 2.0.

**1.8  $\pm 0.4$**  ALDE 84 GAM2 0

• • • We do not use the following data for averages, fits, limits, etc. • • •

2.5 $\pm 0.6$	70	BINON 82	GAM2	See ALDE 84
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### $\Gamma(\pi^0 2\gamma)/\Gamma(3\pi^0)$

VALUE (units $10^{-4}$ )	DOCUMENT ID	TECN	COMMENT
<b><math>8.3 \pm 2.8 \pm 1.4</math></b>	7 KNECHT	04	CRYB $\pi^- p \rightarrow n\eta$

<sup>7</sup> Independent analysis of same data as PRAKHOV 05.

### $\Gamma_4/\Gamma_3$

### $\Gamma(\pi^0 \pi^0 \gamma\gamma)/\Gamma_{\text{total}}$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<b><math>&lt;1.2 \times 10^{-3}</math></b>	90	8 NEFKENS	05A	CRYB $p(720 \text{ MeV}/c) \pi^- \rightarrow n\eta$

<sup>8</sup> Measurement is done in limited  $\gamma-\gamma$  energy range.

### $\Gamma_5/\Gamma$

### $\Gamma(\text{invisible})/\Gamma(2\gamma)$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<b><math>&lt;1.65 \times 10^{-3}</math></b>	90	9 ABLIKIM	06Q	BES2 $J/\psi \rightarrow \phi\eta$

<sup>9</sup> Based on 58M  $J/\psi$  decays.

### $\Gamma_6/\Gamma_2$

## Charged modes

### $\Gamma(\text{neutral modes})/\Gamma(\pi^+ \pi^- \pi^0)$

### $\Gamma_1/\Gamma_8 = (\Gamma_2 + \Gamma_3 + \Gamma_4)/\Gamma_8$

VALUE	EVTS	DOCUMENT ID	TECN
<b><math>3.17 \pm 0.07</math> OUR FIT</b>		Error includes scale factor of 1.3.	

### **$3.26 \pm 0.30$ OUR AVERAGE**

$2.54 \pm 1.89$	74	KENDALL	74	OSPK
$3.4 \pm 1.1$	29	AGUILAR-...	72B	HBC
$2.83 \pm 0.80$	70	<sup>10</sup> BLOODWORTH	72B	HBC
$3.6 \pm 0.6$	244	FLATTE	67B	HBC
$2.89 \pm 0.56$		ALFF-...	66	HBC
$3.6 \pm 0.8$	50	KRAEMER	64	DBC
$3.8 \pm 1.1$		PAULI	64	DBC

<sup>10</sup> Error increased from published value 0.5 by Bloodworth (private communication).

### $\Gamma(2\gamma)/\Gamma(\pi^+ \pi^- \pi^0)$

### $\Gamma_2/\Gamma_8$

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
<b><math>1.74 \pm 0.04</math> OUR FIT</b>		Error includes scale factor of 1.3.		

### **$1.68 \pm 0.10$ OUR AVERAGE**

$1.61 \pm 0.14$		ABLIKIM	06E	BES2 $e^+ e^- \rightarrow J/\psi \rightarrow \eta\gamma$
$1.78 \pm 0.10 \pm 0.13$	1077	AMSLER	95	CBAR $\bar{p}p \rightarrow \pi^+ \pi^- \eta$ at rest
$1.72 \pm 0.25$	401	BAGLIN	69	HLBC
$1.61 \pm 0.39$		FOSTER	65	HBC

### $\Gamma(3\pi^0)/\Gamma(\pi^+ \pi^- \pi^0)$

### $\Gamma_3/\Gamma_8$

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
<b><math>1.434 \pm 0.033</math> OUR FIT</b>		Error includes scale factor of 1.3.		

### **$1.48 \pm 0.05$ OUR AVERAGE**

$1.46 \pm 0.03 \pm 0.09$		ACHASOV	06A	SND $e^+ e^- \rightarrow \eta\gamma$
$1.52 \pm 0.04 \pm 0.08$	23k	<sup>11</sup> AKHMETSHIN	01B	CMD2 $e^+ e^- \rightarrow \phi \rightarrow \eta\gamma$
$1.44 \pm 0.09 \pm 0.10$	1627	AMSLER	95	CBAR $\bar{p}p \rightarrow \pi^+ \pi^- \eta$ at rest
$1.50 \begin{array}{l} +0.15 \\ -0.29 \end{array}$	199	BAGLIN	69	HLBC
$1.47 \begin{array}{l} +0.20 \\ -0.17 \end{array}$		BULLOCK	68	HLBC

• • • We do not use the following data for averages, fits, limits, etc. • • •

1.3 ± 0.4	BAGLIN	67B	HLBC
0.90 ± 0.24	FOSTER	65	HBC
2.0 ± 1.0	FOELSCHE	64	HBC
0.83 ± 0.32	CRAWFORD	63	HBC

<sup>11</sup> AKHMETSHIN 01B uses results from AKHMETSHIN 99F.

### $\Gamma(\pi^+\pi^-\pi^0)/[\Gamma(2\gamma) + \Gamma(3\pi^0)]$

### $\Gamma_8/(\Gamma_2+\Gamma_3)$

VALUE	DOCUMENT ID	TECN	COMMENT
<b>0.315 ± 0.007 OUR FIT</b>	Error includes scale factor of 1.2.		
<b>0.304 ± 0.012</b>	ACHASOV 00D	SND	$e^+e^- \rightarrow \phi \rightarrow \eta\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.3141 ± 0.0081 ± 0.0058	ACHASOV 00B	SND	See ACHASOV 00D

### $\Gamma(\pi^+\pi^-\gamma)/\Gamma(\pi^+\pi^-\pi^0)$

### $\Gamma_9/\Gamma_8$

VALUE	EVTS	DOCUMENT ID	TECN
<b>0.207 ± 0.004 OUR FIT</b>	Error includes scale factor of 1.1.		
<b>0.207 ± 0.004 OUR AVERAGE</b>	Error includes scale factor of 1.1.		
0.209 ± 0.004	18k	THALER 73	ASPK
0.201 ± 0.006	7250	GORMLEY 70	ASPK
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.28 ± 0.04	BALTAY 67B	DBC	
0.25 ± 0.035	LITCHFIELD 67	DBC	
0.30 ± 0.06	CRAWFORD 66	HBC	
0.196 ± 0.041	FOSTER 65C	HBC	

### $\Gamma(e^+e^-\gamma)/\Gamma_{\text{total}}$

### $\Gamma_{10}/\Gamma$

VALUE (units $10^{-3}$ )	EVTS	DOCUMENT ID	TECN	COMMENT
<b>6.0 ± 0.8 OUR FIT</b>	Error includes scale factor of 1.4.			
<b>6.3 ± 1.0 OUR AVERAGE</b>	Error includes scale factor of 1.6.			
5.15 ± 0.62 ± 0.74	283	ACHASOV 01B	SND	$e^+e^- \rightarrow \phi \rightarrow \eta\gamma$
7.10 ± 0.64 ± 0.46	323	AKHMETSHIN 01	CMD2	$e^+e^- \rightarrow \phi \rightarrow \eta\gamma$

### $\Gamma(e^+e^-\gamma)/\Gamma(\pi^+\pi^-\pi^0)$

### $\Gamma_{10}/\Gamma_8$

VALUE (units $10^{-2}$ )	EVTS	DOCUMENT ID	TECN	COMMENT
<b>2.65 ± 0.35 OUR FIT</b>	Error includes scale factor of 1.5.			
<b>2.1 ± 0.5</b>	80	JANE 75B	OSPK	See the erratum

### $\Gamma(\text{neutral modes})/[\Gamma(\pi^+\pi^-\pi^0) + \Gamma(\pi^+\pi^-\gamma) + \Gamma(e^+e^-\gamma)]$

$$\Gamma_1/(\Gamma_8+\Gamma_9+\Gamma_{10}) = (\Gamma_2+\Gamma_3+\Gamma_4)/(\Gamma_8+\Gamma_9+\Gamma_{10})$$

VALUE	EVTS	DOCUMENT ID	TECN
<b>2.57 ± 0.06 OUR FIT</b>	Error includes scale factor of 1.3.		
<b>2.64 ± 0.23</b>	BALTAY 67B	DBC	
• • • We do not use the following data for averages, fits, limits, etc. • • •			
4.5 ± 1.0	280	<sup>12</sup> JAMES 66	HBC
3.20 ± 1.26	53	<sup>12</sup> BASTIEN 62	HBC
2.5 ± 1.0	10	<sup>12</sup> PICKUP 62	HBC

<sup>12</sup> These experiments are not used in the averages as they do not separate clearly  $\eta \rightarrow \pi^+\pi^-\pi^0$  and  $\eta \rightarrow \pi^+\pi^-\gamma$  from each other. The reported values thus probably contain some unknown fraction of  $\eta \rightarrow \pi^+\pi^-\gamma$ .

$$\Gamma(2\gamma)/[\Gamma(\pi^+\pi^-\pi^0) + \Gamma(\pi^+\pi^-\gamma) + \Gamma(e^+e^-\gamma)] \quad \Gamma_2/(\Gamma_8+\Gamma_9+\Gamma_{10})$$

VALUE	EVTS	DOCUMENT ID	TECN
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**1.409±0.030 OUR FIT** Error includes scale factor of 1.3.

**1.1 ±0.4 OUR AVERAGE**

1.51 ± 0.93	75	KENDALL	74	OSPK
0.99 ± 0.48		CRAWFORD	63	HBC

$$\Gamma(\mu^+\mu^-\gamma)/\Gamma_{\text{total}}$$

$$\Gamma_{11}/\Gamma$$

VALUE (units $10^{-4}$ )	EVTS	DOCUMENT ID	TECN	COMMENT
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**3.1±0.4 OUR FIT**

**3.1±0.4** 600 DZHELYADIN 80 SPEC  $\pi^- p \rightarrow \eta n$

• • • We do not use the following data for averages, fits, limits, etc. • • •

1.5 ± 0.75 100 BUSHNIN 78 SPEC See DZHELYADIN 80

$$\Gamma(e^+e^-)/\Gamma_{\text{total}}$$

$$\Gamma_{12}/\Gamma$$

VALUE (units $10^{-4}$ )	CL%	DOCUMENT ID	TECN	COMMENT
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<0.77 90 BROWDER 97B CLE2  $e^+ e^- \simeq 10.5 \text{ GeV}$

• • • We do not use the following data for averages, fits, limits, etc. • • •

<2 90 WHITE 96 SPEC  $p d \rightarrow \eta {}^3\text{He}$

<3 90 DAVIES 74 RVUE Uses ESTEN 67

$$\Gamma(\mu^+\mu^-)/\Gamma_{\text{total}}$$

$$\Gamma_{13}/\Gamma$$

VALUE (units $10^{-6}$ )	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
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**5.8±0.8 OUR AVERAGE**

5.7 ± 0.7 ± 0.5 114 ABEGG 94 SPEC  $p d \rightarrow \eta {}^3\text{He}$

6.5 ± 2.1 27 DZHELYADIN 80B SPEC  $\pi^- p \rightarrow \eta n$

• • • We do not use the following data for averages, fits, limits, etc. • • •

5.6  $^{+0.6}_{-0.7}$  ± 0.5 100 KESSLER 93 SPEC See ABEGG 94

<20 95 0 WEHMANN 68 OSPK

$$\Gamma(\mu^+\mu^-)/\Gamma(2\gamma)$$

$$\Gamma_{13}/\Gamma_2$$

VALUE (units $10^{-5}$ )	DOCUMENT ID	TECN
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• • • We do not use the following data for averages, fits, limits, etc. • • •

5.9 ± 2.2 HYAMS 69 OSPK

$$\Gamma(e^+e^-e^+e^-)/\Gamma_{\text{total}}$$

$$\Gamma_{14}/\Gamma$$

VALUE (units $10^{-5}$ )	CL%	DOCUMENT ID	TECN	COMMENT
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<6.9 90 AKHMETSHIN 01 CMD2  $e^+ e^- \rightarrow \phi \rightarrow \eta \gamma$

$$\Gamma(\pi^+\pi^-e^+e^-)/\Gamma_{\text{total}}$$

$$\Gamma_{15}/\Gamma$$

VALUE (units $10^{-4}$ )	EVTS	DOCUMENT ID	TECN	CHG	COMMENT
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**4.2±1.2 OUR FIT**

**4.1±1.1 OUR AVERAGE**

4.3 ± 1.3 ± 0.4 16 BARGHOLTZ 07 CNTR 0  $p d \rightarrow {}^3\text{He } \eta$

3.7  $^{+2.5}_{-1.8}$  ± 0.3 4 AKHMETSHIN 01 CMD2  $e^+ e^- \rightarrow \phi \rightarrow \eta \gamma$

$\Gamma(\pi^+\pi^-e^+e^-)/\Gamma(\pi^+\pi^-\gamma)$

$\Gamma_{15}/\Gamma_9$

VALUE (units $10^{-2}$ )	EVTS	DOCUMENT ID	TECN
<b><math>0.90 \pm 0.25</math> OUR FIT</b>			
<b>2.6 ± 2.6</b>	1	GROSSMAN	66 HBC

$\Gamma(\pi^+\pi^-2\gamma)/\Gamma(\pi^+\pi^-\pi^0)$

$\Gamma_{16}/\Gamma_8$

VALUE	CL%	DOCUMENT ID	TECN
<0.009		PRICE	67 HBC
• • • We do not use the following data for averages, fits, limits, etc. • • •			
<0.016	95	BALTAY	67B DBC

$\Gamma(\pi^+\pi^-\pi^0\gamma)/\Gamma(\pi^+\pi^-\pi^0)$

$\Gamma_{17}/\Gamma_8$

VALUE (units $10^{-2}$ )	CL%	EVTS	DOCUMENT ID	TECN
<b>&lt;0.24</b>	90	0	THALER	73 ASPK
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<1.7	90		ARNOLD	68 HLBC
<1.6	95		BALTAY	67B DBC
<7.0			FLATTE	67 HBC
<0.9			PRICE	67 HBC

$\Gamma(\pi^0\mu^+\mu^-\gamma)/\Gamma_{\text{total}}$

$\Gamma_{18}/\Gamma$

VALUE (units $10^{-6}$ )	CL%	DOCUMENT ID	TECN	COMMENT
<3	90	DZHELYADIN	81 SPEC	$\pi^- p \rightarrow \eta n$

————— **Forbidden modes** —————

$\Gamma(\pi^0\gamma)/\Gamma_{\text{total}}$

$\Gamma_{19}/\Gamma$

Forbidden by angular momentum conservation.

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<b><math>&lt; 9 \times 10^{-5}</math></b>	90	NEFKENS	05A CRYB	$p(720 \text{ MeV/c}) \pi^- \rightarrow n\eta$

$\Gamma(\pi^+\pi^-)/\Gamma_{\text{total}}$

$\Gamma_{20}/\Gamma$

Forbidden by  $P$  and  $CP$  invariance.

VALUE (units $10^{-4}$ )	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
<b>&lt; 0.13</b>	90	16M	AMBROSINO	05A KLOE	$e^+ e^- \rightarrow \phi \rightarrow \eta\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
< 3.3	90		AKHMETSHIN	99B CMD2	$e^+ e^- \rightarrow \phi \rightarrow \eta\gamma$
< 9	90		AKHMETSHIN	97C CMD2	See AKHMETSHIN 99B
<15	0		THALER	73 ASPK	

$\Gamma(\pi^0\pi^0)/\Gamma_{\text{total}}$

$\Gamma_{21}/\Gamma$

Forbidden by  $P$  and  $CP$  invariance.

VALUE (units $10^{-4}$ )	CL%	DOCUMENT ID	TECN	COMMENT
<b>&lt;4.3</b>	90	AKHMETSHIN	99C CMD2	$e^+ e^- \rightarrow \phi \rightarrow \eta\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<6	90	13 ACHASOV	98 SND	$e^+ e^- \rightarrow \phi \rightarrow \eta\gamma$

<sup>13</sup> ACHASOV 98 observes one event in a  $\pm 3\sigma$  region around the  $\eta$  mass, while a Monte Carlo calculation gives  $10 \pm 5$  events. The limit here is the Poisson upper limit for one observed event and no background.

### $\Gamma(\pi^0\pi^0\gamma)/\Gamma_{\text{total}}$

Forbidden by  $C$  invariance.

VALUE	CL%	DOCUMENT ID	TECN	CHG	COMMENT
$<5 \times 10^{-4}$	90	NEFKENS 05	CRYB	0	p(720 MeV/c) $\pi^- \rightarrow n\eta$

### $\Gamma_{22}/\Gamma$

### $\Gamma(\pi^0\pi^0\pi^0\gamma)/\Gamma_{\text{total}}$

Forbidden by  $C$  invariance.

VALUE	CL%	DOCUMENT ID	TECN	CHG	COMMENT
$<6 \times 10^{-5}$	90	NEFKENS 05	CRYB	0	p(720 MeV/c) $\pi^- \rightarrow n\eta$

### $\Gamma_{23}/\Gamma$

### $\Gamma(3\gamma)/\Gamma_{\text{total}}$

Forbidden by  $C$  invariance.

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

$<4 \times 10^{-5}$	90	NEFKENS 05A	CRYB	p(720 MeV/c) $\pi^- \rightarrow n\eta$
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### $\Gamma_{24}/\Gamma$

### $\Gamma(3\gamma)/\Gamma(2\gamma)$

VALUE (units $10^{-3}$ )	CL%	DOCUMENT ID	TECN	CHG
<1.2	95	ALDE 84	GAM2	0

### $\Gamma_{24}/\Gamma_2$

### $\Gamma(3\gamma)/\Gamma(3\pi^0)$

VALUE (units $10^{-5}$ )	CL%	DOCUMENT ID	TECN	COMMENT
<4.9	90	ALOISIO 04	KLOE	$\phi \rightarrow \eta\gamma$

### $\Gamma_{24}/\Gamma_3$

### $\Gamma(4\pi^0)/\Gamma_{\text{total}}$

Forbidden by  $P$  and  $CP$  invariance.

VALUE (units $10^{-7}$ )	CL%	DOCUMENT ID	TECN	COMMENT
<6.9	90	PRAKHOV 00	CRYB	$\pi^- p \rightarrow n\eta$ , 720 MeV/c

### $\Gamma_{25}/\Gamma$

### $\Gamma(\pi^0 e^+ e^-)/\Gamma_{\text{total}}$

$C$  parity forbids this to occur as a single-photon process.

VALUE (units $10^{-2}$ )	CL%	EVTS	DOCUMENT ID	TECN
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• • • We do not use the following data for averages, fits, limits, etc. • • •

<0.016	90	0	MARTYNOV 76	HLBC
<0.084	90		BAZIN 68	DBC
<0.7			RITTENBERG 65	HBC

### $\Gamma_{26}/\Gamma$

### $\Gamma(\pi^0 e^+ e^-)/\Gamma(\pi^+ \pi^- \pi^0)$

$C$  parity forbids this to occur as a single-photon process.

VALUE (units $10^{-4}$ )	CL%	EVTS	DOCUMENT ID	TECN
< 1.9	90		JANE 75	OSPK

### $\Gamma_{26}/\Gamma_8$

• • • We do not use the following data for averages, fits, limits, etc. • • •

< 42	90		BAGLIN 67	HLBC
< 16	90	0	BILLING 67	HLBC
< 77		0	FOSTER 65B	HBC
<110			PRICE 65	HBC

### $\Gamma(\pi^0 \mu^+ \mu^-)/\Gamma_{\text{total}}$

*C* parity forbids this to occur as a single-photon process.

VALUE (units $10^{-4}$ )	CL%	DOCUMENT ID	TECN	COMMENT
<0.05	90	DZHELYADIN 81	SPEC	$\pi^- p \rightarrow \eta n$
$\bullet \bullet \bullet$ We do not use the following data for averages, fits, limits, etc. $\bullet \bullet \bullet$				
<5		WEHMANN 68	OSPK	

### $[\Gamma(\mu^+ e^-) + \Gamma(\mu^- e^+)/\Gamma_{\text{total}}$

Forbidden by lepton family number conservation.

VALUE (units $10^{-6}$ )	CL%	DOCUMENT ID	TECN	COMMENT
<6	90	WHITE	96	$p d \rightarrow \eta {}^3\text{He}$

## $\eta$ C-NONCONSERVING DECAY PARAMETERS

### $\pi^+ \pi^- \pi^0$ LEFT-RIGHT ASYMMETRY PARAMETER

Measurements with an error  $> 1.0 \times 10^{-2}$  have been omitted.

VALUE (units $10^{-2}$ )	EVTS	DOCUMENT ID	TECN
<b>0.09 ± 0.17 OUR AVERAGE</b>			
0.28 ± 0.26	165k	JANE	74 OSPK
-0.05 ± 0.22	220k	LAYER	72 ASPK
$\bullet \bullet \bullet$ We do not use the following data for averages, fits, limits, etc. $\bullet \bullet \bullet$			
1.5 ± 0.5	37k	<sup>14</sup> GORMLEY	68C ASPK

<sup>14</sup>The GORMLEY 68C asymmetry is probably due to unmeasured (**E** × **B**) spark chamber effects. New experiments with (**E** × **B**) controls don't observe an asymmetry.

### $\pi^+ \pi^- \pi^0$ SEXTANT ASYMMETRY PARAMETER

Measurements with an error  $> 2.0 \times 10^{-2}$  have been omitted.

VALUE (units $10^{-2}$ )	EVTS	DOCUMENT ID	TECN
<b>0.18 ± 0.16 OUR AVERAGE</b>			
0.20 ± 0.25	165k	JANE	74 OSPK
0.10 ± 0.22	220k	LAYER	72 ASPK
0.5 ± 0.5	37k	GORMLEY	68C WIRE

### $\pi^+ \pi^- \pi^0$ QUADRANT ASYMMETRY PARAMETER

VALUE (units $10^{-2}$ )	EVTS	DOCUMENT ID	TECN
<b>-0.17 ± 0.17 OUR AVERAGE</b>			
-0.30 ± 0.25	165k	JANE	74 OSPK
-0.07 ± 0.22	220k	LAYER	72 ASPK

### $\pi^+ \pi^- \gamma$ LEFT-RIGHT ASYMMETRY PARAMETER

Measurements with an error  $> 2.0 \times 10^{-2}$  have been omitted.

VALUE (units $10^{-2}$ )	EVTS	DOCUMENT ID	TECN
<b>0.9 ± 0.4 OUR AVERAGE</b>			
1.2 ± 0.6	35k	JANE	74B OSPK
0.5 ± 0.6	36k	THALER	72 ASPK
1.22 ± 1.56	7257	GORMLEY	70 ASPK

## $\pi^+ \pi^- \gamma$ PARAMETER $\beta$ (*D*-wave)

Sensitive to a *D*-wave contribution:  $dN/d\cos\theta = \sin^2\theta (1 + \beta \cos^2\theta)$ .

VALUE	EVTS	DOCUMENT ID	TECN
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**-0.02 ± 0.07 OUR AVERAGE** Error includes scale factor of 1.3.

0.11 ± 0.11	35k	JANE	74B OSPK
-0.060 ± 0.065	7250	GORMLEY	70 WIRE

• • • We do not use the following data for averages, fits, limits, etc. • • •

0.12 ± 0.06	15 THALER	72 ASPK
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<sup>15</sup> The authors don't believe this indicates *D*-wave because the dependence of  $\beta$  on the  $\gamma$  energy is inconsistent with the theoretical prediction. A  $\cos^2\theta$  dependence can also come from *P*- and *F*-wave interference.

## ENERGY DEPENDENCE OF $\eta \rightarrow 3\pi$ DALITZ PLOTS

### PARAMETERS FOR $\eta \rightarrow \pi^+ \pi^- \pi^0$

See the "Note on  $\eta$  Decay Parameters" in our 1994 edition, Phys. Rev. **D50**, 1 August 1994, Part I, p. 1454. The following experiments fit to one or more of the coefficients  $a, b, c, d$ , or  $e$  for  $|\text{matrix element}|^2 = 1 + ay + by^2 + cx + dx^2 + exy$ .

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

3230	16 ABELE	98D CBAR	$\bar{p}p \rightarrow \pi^0 \pi^0 \eta$ at rest
1077	17 AMSLER	95 CBAR	$\bar{p}p \rightarrow \pi^+ \pi^- \eta$ at rest
81k	LAYTER	73 ASPK	
220k	LAYTER	72 ASPK	
1138	CARPENTER	70 HBC	
349	DANBURG	70 DBC	
7250	GORMLEY	70 WIRE	
526	BAGLIN	69 HLBC	
7170	CNOPS	68 OSPK	
37k	GORMLEY	68C WIRE	
1300	CLPWY	66 HBC	
705	LARRIBE	66 HBC	

<sup>16</sup> ABELE 98D obtains  $a = -1.22 \pm 0.07$  and  $b = 0.22 \pm 0.11$  when  $c$  (our  $d$ ) is fixed at 0.06.

<sup>17</sup> AMSLER 95 fits to  $(1+ay+by^2)$  and obtains  $a = -0.94 \pm 0.15$  and  $b = 0.11 \pm 0.27$ .

### $\alpha$ PARAMETER FOR $\eta \rightarrow 3\pi^0$

See the "Note on  $\eta$  Decay Parameters" in our 1994 edition, Phys. Rev. **D50**, 1 August 1994, Part I, p. 1454. The value here is of  $\alpha$  in  $|\text{matrix element}|^2 = 1 + 2\alpha z$ .

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
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**-0.031 ± 0.004 OUR AVERAGE** Error includes scale factor of 1.1.

-0.010 ± 0.021 ± 0.010	12k	ACHASOV	01C SND	$e^+ e^- \rightarrow \phi \rightarrow \eta\gamma$
-0.031 ± 0.004	1M	TIPPENS	01 CRYB	$\pi^- p \rightarrow n\eta, 720 \text{ MeV}/c$
-0.052 ± 0.017 ± 0.010	98k	ABELE	98C CBAR	$\bar{p}p \rightarrow 5\pi^0$
-0.022 ± 0.023	50k	ALDE	84 GAM2	
-0.32 ± 0.37	192	BAGLIN	70 HLBC	

• • • We do not use the following data for averages, fits, limits, etc. • • •

## $\eta$ REFERENCES

BARGHOLTZ	07	PL B644 299	Chr. Bargholtz <i>et al.</i>	(CELSIUS-WASA Collab.)
ABLIKIM	06E	PR D73 052008	M. Ablikim <i>et al.</i>	(BES Collab.)
ABLIKIM	06Q	PRL 97 202002	M. Ablikim <i>et al.</i>	(BES Collab.)
ACHASOV	06A	PR D74 014016	M.N. Achasov <i>et al.</i>	(SND Collab.)
ABDEL-BARY	05	PL B619 281	M. Abdel-Bary <i>et al.</i>	(GEM Collab.)
AKHMETSHIN	05	PL B605 26	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
AMBROSINO	05A	PL B606 276	F. Ambrosino <i>et al.</i>	(KLOE Collab.)
NEFKENS	05	PRL 94 041601	B.M.K. Nefkens <i>et al.</i>	(BNL Crystal Ball Collab.)
NEFKENS	05A	PR C72 035212	B.M.K. Nefkens <i>et al.</i>	(BNL Crystal Ball Collab.)
PRAKHOV	05	PR C72 025201	S. Prakhov <i>et al.</i>	(BNL Crystal Ball Collab.)
ALOISIO	04	PL B591 49	A. Aloisio <i>et al.</i>	(KLOE Collab.)
KNECHT	04	PL B589 14	N. Knecht <i>et al.</i>	
LAI	02	PL B533 196	A. Lai <i>et al.</i>	(CERN NA48 Collab.)
NEFKENS	02	PS T99 114	B.M.K. Nefkens, J.W. Price	(UCLA)
ACHASOV	01B	PL B504 275	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
ACHASOV	01C	JETPL 73 451	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
		Translated from ZETFP 73 511.		
ACHASOV	01D	NP B600 3	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
AKHMETSHIN	01	PL B501 191	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
AKHMETSHIN	01B	PL B509 217	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
TIPPENS	01	PRL 87 192001	W.B. Tippens <i>et al.</i>	(BNL Crystal Ball Collab.)
ACHASOV	00	EPJ C12 25	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
ACHASOV	00B	JETP 90 17	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
		Translated from ZETF 117 22.		
ACHASOV	00D	JETPL 72 282	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
		Translated from ZETFP 72 411.		
PRAKHOV	00	PRL 84 4802	S. Prakhov <i>et al.</i>	(BNL Crystal Ball Collab.)
AKHMETSHIN	99B	PL B462 371	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
AKHMETSHIN	99C	PL B462 380	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
AKHMETSHIN	99F	PL B460 242	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
ABELE	98C	PL B417 193	A. Abele <i>et al.</i>	(Crystal Barrel Collab.)
ABELE	98D	PL B417 197	A. Abele <i>et al.</i>	(Crystal Barrel Collab.)
ACHASOV	98	PL B425 388	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
AKHMETSHIN	97C	PL B415 452	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
BROWDER	97B	PR D56 5359	T.E. Browder <i>et al.</i>	(CLEO Collab.)
ABEGG	96	PR D53 11	R. Abegg <i>et al.</i>	(Saturne SPES2 Collab.)
WHITE	96	PR D53 6658	D.B. White <i>et al.</i>	(Saturne SPES2 Collab.)
AMSLER	95	PL B346 203	C. Amsler <i>et al.</i>	(Crystal Barrel Collab.)
KRUSCHE	95D	ZPHY A351 237	B. Krusche <i>et al.</i>	(TAPS + A2 Collab.)
ABEGG	94	PR D50 92	R. Abegg <i>et al.</i>	(Saturne SPES2 Collab.)
AMSLER	93	ZPHY C58 175	C. Amsler <i>et al.</i>	(Crystal Barrel Collab.)
KESSLER	93	PRL 70 892	R.S. Kessler <i>et al.</i>	(Saturne SPES2 Collab.)
PLOUIN	92	PL B276 526	F. Plouin <i>et al.</i>	(Saturne SPES4 Collab.)
BARU	90	ZPHY C48 581	S.E. Baru <i>et al.</i>	(MD-1 Collab.)
ROE	90	PR D41 17	N.A. Roe <i>et al.</i>	(ASP Collab.)
WILLIAMS	88	PR D38 1365	D.A. Williams <i>et al.</i>	(Crystal Ball Collab.)
AIHARA	86	PR D33 844	H. Aihara <i>et al.</i>	(TPC-2 $\gamma$ Collab.)
BARTEL	85E	PL 160B 421	W. Bartel <i>et al.</i>	(JADE Collab.)
LANDSBERG	85	PRPL 128 310	L.G. Landsberg	(SERP)
ALDE	84	ZPHY C25 225	D.M. Alde <i>et al.</i>	(SERP, BELG, LAPP)
Also		SJNP 40 918	D.M. Alde <i>et al.</i>	(SERP, BELG, LAPP)
		Translated from YAF 40 1447.		
WEINSTEIN	83	PR D28 2896	A.J. Weinstein <i>et al.</i>	(Crystal Ball Collab.)
BINON	82	SJNP 36 391	F.G. Binon <i>et al.</i>	(SERP, BELG, LAPP+)
Also		Translated from YAF 36 670.		
DAVYDOV	81	NC 71A 497	F.G. Binon <i>et al.</i>	(SERP, BELG, LAPP+)
Also		LNC 32 45	V.A. Davyдов <i>et al.</i>	(SERP, BELG, LAPP+)
		SJNP 33 825	V.A. Davyдов <i>et al.</i>	(SERP, BELG, LAPP+)
DZHELYADIN	81	PL 105B 239	R.I. Dzhelyadin <i>et al.</i>	(SERP)
Also		SJNP 33 822	R.I. Dzhelyadin <i>et al.</i>	(SERP)
		Translated from YAF 33 1534.		
ABROSIMOV	80	SJNP 31 195	A.T. Abrosimov <i>et al.</i>	(JINR)
		Translated from YAF 31 371.		
DZHELYADIN	80	PL 94B 548	R.I. Dzhelyadin <i>et al.</i>	(SERP)
Also		SJNP 32 516	R.I. Dzhelyadin <i>et al.</i>	(SERP)
		Translated from YAF 32 998.		
DZHELYADIN	80B	PL 97B 471	R.I. Dzhelyadin <i>et al.</i>	(SERP)
Also		SJNP 32 518	R.I. Dzhelyadin <i>et al.</i>	(SERP)
		Translated from YAF 32 1002.		

BUSHNIN	78	PL 79B 147	Y.B. Bushnin <i>et al.</i>	(SERP)
Also		SJNP 28 775	Y.B. Bushnin <i>et al.</i>	(SERP)
MARTYNOV	76	Translated from YAF 28 1507. SJNP 23 48	A.S. Martynov <i>et al.</i>	(JINR)
JANE	75	Translated from YAF 23 93. PL 59B 99	M.R. Jane <i>et al.</i>	(RHEL, LOWC)
JANE	75B	PL 59B 103	M.R. Jane <i>et al.</i>	(RHEL, LOWC)
Also		PL 73B 503	M.R. Jane	
Erratum in private communication.				
BROWMAN	74B	PRL 32 1067	A. Browman <i>et al.</i>	(CORN, BING)
DAVIES	74	NC 24A 324	J.D. Davies, J.G. Guy, R.K.P. Zia	(BIRM, RHEL+)
DUANE	74	PRL 32 425	A. Duane <i>et al.</i>	(LOIC, SHMP)
JANE	74	PL 48B 260	M.R. Jane <i>et al.</i>	(RHEL, LOWC, SUSS)
JANE	74B	PL 48B 265	M.R. Jane <i>et al.</i>	(RHEL, LOWC, SUSS)
KENDALL	74	NC 21A 387	B.N. Kendall <i>et al.</i>	(BROW, BARI, MIT)
LAYER	73	PR D7 2565	J.G. Layer <i>et al.</i>	(COLU)
THALER	73	PR D7 2569	J.J. Thaler <i>et al.</i>	(COLU)
AGUILAR-...	72B	PR D6 29	M. Aguilar-Benitez <i>et al.</i>	(BNL)
BLOODWORTH	72B	NP B39 525	I.J. Bloodworth <i>et al.</i>	(TNTO)
LAYER	72	PRL 29 316	J.G. Layer <i>et al.</i>	(COLU)
THALER	72	PRL 29 313	J.J. Thaler <i>et al.</i>	(COLU)
BASILE	71D	NC 3A 796	M. Basile <i>et al.</i>	(CERN, BGNA, STRB)
STRUGALSKI	71	NP B27 429	Z.S. Strugalski <i>et al.</i>	(JINR)
BAGLIN	70	NP B22 66	C. Baglin <i>et al.</i>	(EPOL, MADR, STRB)
BUTTRAM	70	PRL 25 1358	M.T. Buttram, M.N. Kreisler, R.E. Mischke	(PRIN)
CARPENTER	70	PR D1 1303	D.W. Carpenter <i>et al.</i>	(DUKE)
COX	70B	PRL 24 534	B. Cox, L. Fortney, J.P. Golson	(DUKE)
DANBURG	70	PR D2 2564	J.S. Danburg <i>et al.</i>	(RLR)
DEVONS	70	PR D1 1936	S. Devons <i>et al.</i>	(COLU, SYRA)
GORMLEY	70	PR D2 501	M. Gormley <i>et al.</i>	(COLU, BNL)
Also		Thesis Nevis 181	M. Gormley	(COLU)
BAGLIN	69	PL 29B 445	C. Baglin <i>et al.</i>	(EPOL, UCB, MADR, STRB)
Also		NP B22 66	C. Baglin <i>et al.</i>	(EPOL, MADR, STRB)
HYAMS	69	PL 29B 128	B.D. Hyams <i>et al.</i>	(CERN, MPIM)
ARNOLD	68	PL 27B 466	R.G. Arnold <i>et al.</i>	(STRB, MADR, EPOL+)
BAZIN	68	PRL 20 895	M.J. Bazin <i>et al.</i>	(PRIN, QUKI)
BULLOCK	68	PL 27B 402	F.W. Bullock <i>et al.</i>	(LOUC)
CNOPS	68	PRL 21 1609	A.M. Cnops <i>et al.</i>	(BNL, ORNL, UCND+)
GORMLEY	68C	PRL 21 402	M. Gormley <i>et al.</i>	(COLU, BNL)
WEHMANN	68	PRL 20 748	A.W. Wehmann <i>et al.</i>	(HARV, CASE, SLAC+)
BAGLIN	67	PL 24B 637	C. Baglin <i>et al.</i>	(EPOL, UCB)
BAGLIN	67B	BAPS 12 567	C. Baglin <i>et al.</i>	(EPOL, UCB)
BALTAY	67B	PRL 19 1498	C. Baltay <i>et al.</i>	(COLU, STON)
BALTAY	67D	PRL 19 1495	C. Baltay <i>et al.</i>	(COLU, BRAN)
BEMPORAD	67	PL 25B 380	C. Bemporad <i>et al.</i>	(PISA, BONN)
Also		Private Comm.	I. Ion	
BILLING	67	PL 25B 435	K.D. Billing <i>et al.</i>	(LOUC, OXF)
BUNIATOV	67	PL 25B 560	S.A. Bunyatov <i>et al.</i>	(CERN, KARL)
CENCE	67	PRL 19 1393	R.J. Cence <i>et al.</i>	(HAWA, LRL)
ESTEN	67	PL 24B 115	M.J. Esten <i>et al.</i>	(LOUC, OXF)
FELDMAN	67	PRL 18 868	M. Feldman <i>et al.</i>	(PENN)
FLATTE	67	PRL 18 976	S.M. Flatte	(LRL)
FLATTE	67B	PR 163 1441	S.M. Flatte, C.G. Wohl	(LRL)
LITCHFIELD	67	PL 24B 486	P.J. Litchfield <i>et al.</i>	(RHEL, SACL)
PRICE	67	PRL 18 1207	L.R. Price, F.S. Crawford	(LRL)
ALFF-...	66	PR 145 1072	C. Alff-Steinberger <i>et al.</i>	(COLU, RUTG)
CLPWY	66	PR 149 1044	C. Baltay	(SCUC, LRL, PURD, WISC, YALE)
CRAWFORD	66	PRL 16 333	F.S. Crawford, L.R. Price	(LRL)
DIGIUGNO	66	PRL 16 767	G. di Giugno <i>et al.</i>	(NAPL, TRST, FRAS)
GROSSMAN	66	PR 146 993	R.A. Grossman, L.R. Price, F.S. Crawford	(LRL)
GRUNHAUS	66	Thesis	J. Grunhaus	(COLU)
JAMES	66	PR 142 896	F.E. James, H.L. Kraybill	(YALE, BNL)
JONES	66	PL 23 597	W.G. Jones <i>et al.</i>	(LOIC, RHEL)
LARRIBE	66	PL 23 600	A. Larrike <i>et al.</i>	(SACL, RHEL)
FOSTER	65	PR 138B 652	M. Foster <i>et al.</i>	(WISC, PURD)
FOSTER	65B	Athens Conf.	M. Foster, M. Good, M. Meer	(WISC)
FOSTER	65C	Thesis	M. Foster	(WISC)
PRICE	65	PRL 15 123	L.R. Price, F.S. Crawford	(LRL)
RITTENBERG	65	PRL 15 556	A. Rittenberg, G.R. Kalbfleisch	(LRL, BNL)
FOELSCH	64	PR 134B 1138	H.W.J. Foelsche, H.L. Kraybill	(YALE)
KRAEMER	64	PR 136B 496	R.W. Kraemer <i>et al.</i>	(JHU, NWES, WOOD)
PAULI	64	PL 13 351	E. Pauli, A. Muller	(SACL)

BACCI	63	PRL 11 37	C. Bacci <i>et al.</i>	(ROMA, FRAS)
CRAWFORD	63	PRL 10 546	F.S.Jr. Crawford, L.J. Lloyd, E.C. Fowler	(LRL+)
Also		PRL 16 907	F.S. Crawford, L.J. Lloyd, E.C. Fowler	(LRL+)
ALFF-...	62	PRL 9 322	C. Alff-Steinberger <i>et al.</i>	(COLU, RUTG)
BASTIEN	62	PRL 8 114	P.L. Bastien <i>et al.</i>	(LRL)
PICKUP	62	PRL 8 329	E. Pickup, D.K. Robinson, E.O. Salant	(CNRC+)

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